Portions of pages 7 and 8 of the specification have been amended simply to make the amended paragraphs synonymous with the amendments to claims 3 and 4 as described immediately below.

Claims 3 and 4 stand rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention. Applicant has amended claims 3 and 4 using the claim terminology "said" to set forth appropriate antecedent basis for "the fins" and "the spreader plate".

As for "the flowing fluid" terminology of claims 3 and 4, Applicant has amended these claims to clarify that the flowing fluid is a cooling fluid, such as air or water, that passes or flows across the fins to dissipate any heat that is generated by the electrical or electronic components. Also, the terminology "cooling fluid" has been appropriately incorporated into amended claim 1 to establish antecedent for claims 3 and 4.

In accordance with MPEP 2163.06 "...information contained ***in any one*** of the specification, claims or drawings of the application as filed may be added to any other part of the application without introducing new matter" (*emphasis added*). The cooling fluid, i.e., a flowing fluid, is appropriately disclosed throughout the specification as originally filed. For instance, the cooling fluid was described at:

page 1, line 8; page 2, lines 5-10;
page 1, line 21 to page 2, line 1; page 5, lines 10-11;
etc.

Therefore, in accordance with MPEP 2163.06, no new matter is being introduced by the amendment for the "cooling fluid" in claims 1, 3, and 4, and the Examiner's §112, second paragraph, rejections of claims 3 and 4 are remedied as appropriate antecedent basis for the claimed subject matter now exists.

Claims 1, 2, 5, 6, and 7 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Elwell (United States Patent No. 5,315,154). Claim 3 stands rejected under 35 U.S.C. §

103(a) as being anticipated by Elwell in view of Lindquist et al. (United States Patent No. 5,304,845). Claim 4 stands rejected under 35 U.S.C. § 103(a) as being anticipated by Elwell in view of McCoy et al. (United States Patent No. 4,714,049).

In addition to a heat spreader plate and at least two heat conducting fins, amended claim 1 of the subject application requires that the heat sink also include at least one foam block. More specifically, independent claim 1 has been amended to clarify that this foam block, which is disposed in the space between parallel fins, is formed of reticulated foam. As such, the reticulated foam block defines a highly porous, heat conducting, open-celled structure that permits a cooling fluid to flow through said block as the cooling fluid passes across said fins.

Therefore, the block, as now more clearly claimed in amended claim 1, must be foam. Furthermore, as now claimed, this foam block must be formed of reticulated foam such that a highly porous, heat conducting, open-celled structure is defined. As a result, as described throughout the specification as originally submitted, any pressure drop of the cooling fluid as it passes through the foam block is minimized. With any pressure drop minimized, movement, or flow, of the cooling fluid through the foam block is practical.

As the Examiner indicates on page 4 of the Office Action, the '154 patent to Elwell discloses an electronic assembly including a heat absorbing material. The electronic assembly of Elwell includes a heat spreader plate (12), at least two heat conducting fins (12b), and the heat absorbing material (16). Elwell also discloses that the heat absorbing material (16) is a solid phase change material or PCM (16). Throughout the entire specification of Elwell, the PCM is disclosed as a solid polyhydric alcohol such as neopentyl glycol, trimethylol ethane, and pentaerythritol. Polyhydric alcohols are better known in the art as polyols.

Elwell does not disclose, teach, or suggest the heat sink as claimed. Specifically, Elwell does not disclose, teach, or suggest at least one ***foam*** block that is disposed in the space between parallel fins. More specifically, Elwell does not disclose, teach, or suggest a foam block that is formed of reticulated foam to define a highly porous, heat conducting,

open-celled structure. The PCM disclosed in Elwell is clearly not a foam block and is clearly formed of reticulated foam. In fact, the '154 patent to Elwell never even uses the word "foam" at all.

As further evidence that Elwell does not disclose, teach, or suggest the claimed invention, the PCM of Elwell is a solid material (*see the entire specification of Elwell*), not a reticulated, i.e., open-celled, material as claimed in claim 1 of the subject application. Furthermore, certain embodiments of the solid PCM disclosed in the '154 patent are water soluble, and these embodiments utilize a cover (18). As stated at column 4, lines 51-62, the cover (18) typically provides an impervious, hermetic (i.e., air tight) seal. In either situation, the solid (non-reticulated) PCM of Elwell, with or without a cover, is not conducive to low pressure drop and ideal air flow of the cooling fluid throughout the heat sink.

In sum, the Applicant respectfully submits that the Examiner has misconstrued the disclosure of the '154 patent relative to the heat sink claimed in claim 1 of the subject application because the PCM of Elwell is not the foam block formed of reticulated foam as now claimed in amended claim 1. Therefore, upon a proper interpretation of the '154 patent, independent claim 1, as amended, is allowable. Claims 2-7 depend, either directly or indirectly, on the novel and non-obvious features of claim 1 such that these claims are also allowable.

Because Elwell does not disclose, teach, or suggest each and every element of the invention as claimed in claim 1, Applicant also submits that the § 103(a) rejections of claims 3 and 4 combining Elwell with Lindquist et al. and McCoy et al., respectively, are overcome. Hence, these claims are allowable.

Finally, in accordance with MPEP 2163.06, newly added claims 21-28 do not introduce new matter as the Applicant is simply claiming, in a dependent format, connection of the components through thermal bonding which was adequately described in the specification as originally filed at page 9, lines 1-8. Furthermore, like dependent claims 2-7, newly added claims 21-28 also depend, either directly or indirectly, from the novelty and non-obvious

features of claim 1 such that these claims are also allowable.

It is respectfully submitted that the Application is presented in condition for allowance, which allowance is respectfully solicited.

No fees are believed to be due. However, if necessary, the Commissioner is authorized to charge Deposit Account No. 50-0831 for any additional fees or to credit the account for any overpayment.

Respectfully submitted,

Date: 7-17-02

Patrick M. Griffin, Registration No. 29,716
Delphi Technologies, Inc.
Legal Staff
M/C 480-410-202
P.O. Box 5052
Troy, Michigan 48007-5052
(248) 813-1215

CERTIFICATE OF MAILING

I hereby certify that the attached **Amendment** is being deposited with the United States Postal Service as first class mail, postage prepaid, in an envelope addressed to the **Box Non-Fee Amendment, Assistant Commissioner for Patents, Washington, DC 20231**, on 18-July-2002.

Brendon D. Chambers

BRENDON D. CHAMBERS

VERSION OF THE SPECIFICATION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

On page 7, please replace the second full paragraph (which continues to page 8 and begins with "In preferred heat sinks…") with the following:

In preferred heat sinks of the present invention, the fin spacing and fin (and foam) height are optimized according to the following formulas. Based on heat transfer considerations, the optimum fin height (as shown in Fig. 2a), **b**, is determined using the relation,

$$b = 0.6498\sqrt{\frac{k_f \delta_f}{h}} \qquad (1)$$

where,

k_f is the thermal conductivity of the selected fin material, Btu/ft s °F

δ_f is the fin thickness, ft

h is the convective heat transfer coefficient for the foam-filled space bounded by the fins and the heat spreader plate, Btu/ft^2 s °F, and where h is given by the formula,

$$h = 1.2704\left[\frac{n^{0.50}}{(1-\phi)^{0.25}}\right]\left(\frac{\rho^{0.50} k^{0.63} c_p^{0.37}}{\mu^{0.13}}\right) u_m^{0.50} \qquad (2)$$

where,

n is the linear density of the foam [material] block or blocks, pores per ft

ϕ is the [foam] porosity of the foam block or blocks, expressed as a fraction

ρ is the density of the [flowing] cooling fluid that passes across the fins, lb_m/ft^3

k is the thermal conductivity of the [flowing] cooling fluid, Btu/ft s °F

c_p is the isobaric specific heat of the [flowing] cooling fluid, Btu/lb_m °F

μ is the dynamic viscosity of the [flowing] cooling fluid, $lb_m/ft\ s$

u_m is the mean velocity of the [flowing] cooling fluid, ft/s.

On page 8, please replace the second full paragraph (which begins with "Based on heat transfer considerations...") with the following:

Based on heat transfer considerations, the minimum fin spacing δ is determined by the relation,

$$\delta = 7.32\sqrt{\frac{kc}{\rho c_p u_m}} \qquad (4)$$

where,

c is the fin length in the flow direction (as shown in Fig. 26), ft

k is the thermal conductivity of the [flowing] cooling fluid, Btu/ft s ^oF

ρ is the density of the [flowing] cooling fluid lb_m/ft^3

c_p is the isobaric specific heat of the [flowing] cooling fluid, $Btu/lb_m{}^oF$

u_m is the mean velocity of the [flowing] cooling fluid, ft/s.

VERSION OF CLAIMS WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Please cancel claims 8-20 without prejudice.

Please replace claims 1-7 with the following:

1. (Amended) A heat sink for electrical or electronic components comprising:

a heat spreader plate to which the components to be cooled are connected;

at least two heat conducting fins that are positioned substantially parallel to one another and which are connected substantially perpendicular to said heat spreader plate; and

at least one [highly porous heat conducting reticulated] foam block that [fills] is disposed in the space between parallel fins wherein said block is formed of reticulated foam to define a highly porous, heat conducting, open-celled structure that permits a cooling fluid to flow through said block as the cooling fluid passes across said fins.

2. (Amended) A heat sink of claim [1] 22 wherein said fins and said foam blocks are connected to one surface of said heat spreader plate.

3. (Amended) A heat sink of claim 1 wherein the fin height, **b**, is determined by the relationship,

$$b = 0.6498\sqrt{\frac{k_f \delta_f}{h}}$$

where,

k_f is the thermal conductivity of the selected fin material, Btu/ft s °F

δ_f is the fin thickness, ft

h is the convective heat transfer coefficient for the foam-filled space bounded by [the] said fins and [the] said heat spreader plate, Btu/ft^2 s °F, and where h is given by the formula,

$$h = 1.2704\left[\frac{n^{0.50}}{(1-\phi)^{0.25}}\right]\left(\frac{\rho^{0.50}k^{0.63}c_p^{0.37}}{\mu^{0.13}}\right)u_m^{0.50}$$

where,

n is the linear density of [the] said at least one foam [material] block, pores per ft

ϕ is the [foam] porosity of said at least one foam block, expressed as a fraction

ρ is the density of the [flowing] cooling fluid that passes across said fins, lb_m/ft^3

k is the thermal conductivity of the [flowing] cooling fluid, Btu/ft s ^oF

c_p is the isobaric specific heat of the [flowing] cooling fluid, Btu/lb_m ^oF

μ is the dynamic viscosity of the [flowing] cooling fluid, lb_m/ft s

u_m is the mean velocity of the [flowing] cooling fluid, ft/s

4. (Amended) A heat sink of claim 1 wherein the fin spacing, **a**, is determined by the relationship,

$$a = \Phi\delta$$

where,

Φ is between 1 to 6

δ, ft, is determined by the relation,

$$\delta = 7.32\sqrt{\frac{kc}{\rho c_p u_m}}$$

where,

c is the selected fin length in the flow direction, ft

k is the thermal conductivity of the [flowing] cooling fluid that passes across said fins, Btu/ft s ^oF

ρ is the density of the [flowing] cooling fluid lb_m/ft^3

c_p is the isobaric specific heat of the [flowing] cooling fluid, $Btu/lb_m{}^oF$

u_m is the mean velocity of the [flowing] cooling fluid, ft/s.

5. (Amended) A heat sink of claim 1 wherein said heat spreader plate, said fins and said at least one [heat conducting] foam block are made from the same or different thermal conducting materials.

6. (Amended) A heat sink of claim 1 wherein said heat spreader plate, said fins and said at least one [heat conducting] foam block are made from aluminum, copper, graphite or aluminum-nitride ceramic.

7. (Amended) A heat sink of claim 1 wherein said heat spreader plate, said fins and said at least one [heat conducting] foam block are made from aluminum.